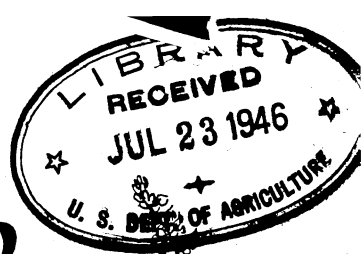


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# SWEETCLOVER

*in* CORN BELT  
FARMING



FARMERS'  
BULLETIN  
NO. 1653

U. S. DEPARTMENT  
OF AGRICULTURE

**S**WEETCLOVER, a roadside weed 30 years ago, is now a crop of considerable economic importance in the Corn Belt.

It fits readily into most of the established cropping systems, and in many sections is the most important leguminous crop grown.

Sweetclover produces an abundance of pasture; is unequalled by any other legume for soil improvement; is drought-resistant when once established; and may be used for hay.

If late-maturing varieties are used and properly handled the first- and second-year growths will furnish continuous grazing throughout the growing season. This makes it of exceptional value as a pasture crop, especially for dairy cows.

This bulletin outlines some of the essentials for successful sweetclover production and the important practices that have developed on farms on which sweetclover is being most effectively utilized.

Cropping systems for different types of farming and for different sections of the Corn Belt are outlined.

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Washington, D. C.

Issued January 1931  
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# SWEETCLOVER IN CORN BELT FARMING

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## INTRODUCTION

TREMENDOUS EXPANSION in the use of sweetclover has occurred on Corn Belt farms during the last 20 years.<sup>2</sup> Sweetclover is used mainly as a temporary pasture or as a means of maintaining or restoring fertility to soils that have been depleted by long-continued cropping with corn and small grain and is well established as a regular crop in the organization of farms in many sections of the Corn Belt. Its outstanding value as a pasture and soil-improving crop, the relative cheapness of the seed, and the ease with which it may be fitted into established cropping systems have all contributed to this widespread use.

Naturally its use has increased most rapidly in those sections that possess a neutral or alkaline soil, but it also has become firmly fixed as a part of the cropping system in many sections where liming and inoculation are absolutely necessary for its production.

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<sup>2</sup> Two species and one botanical variety of sweetclover are grown in the Corn Belt. Biennial white (*Melilotus alba*), usually called white or common white, and biennial yellow (*M. officinalis*), commonly called yellow or yellow blossom, are the species, and Hubam, an annual variety of the biennial white, is the botanical variety. Grundy County and Arctic are smaller and early-maturing varieties of the biennial white, and Madrid Yellow and Albotrea are varieties of the biennial yellow. Ohio Evergreen and Iowa Late White are late-maturing varieties, while Madrid White matures in midseason. The common white biennial, composed of many different types, is by far the most important and constitutes approximately 85 percent of all sweetclover grown in the Corn Belt. Unless otherwise indicated, all discussion in this bulletin refers to the common white. As sweetclover reaches maturity in the early fall of the second year the terms "first-year crop" and "second-year crop" are used to designate, respectively, the growth produced the year of seeding and the year after seeding.

Requirements for growing sweetclover are generally known, but there is still a strong demand for information in regard to the most effective methods of utilizing the crop. This bulletin is based on data obtained in 1929 from a study of methods of growing and utilizing sweetclover on more than 200 Corn Belt farms on which sweetclover had been used from 3 to 18 years, and on several years' field observations.<sup>3</sup>

#### ESSENTIALS FOR SUCCESS WITH SWEETCLOVER

Briefly, lime and inoculation are essential for the successful production of sweetclover. The crop can be grown practically anywhere in the Corn Belt if soil acidity is corrected. Inoculation is essential in all sections in which the bacteria required by sweetclover are not already present in the soil. A firm seedbed is important in securing a satisfactory stand, especially if spring seeding is delayed or late summer seeding is practiced.

#### LIMING

Lime is the most important single requirement for successful sweetclover production. The crop is highly sensitive to an acid condition of the soil, and probably more failures have been due to lack of lime in the soil than to any other one cause. Fortunately portions of the Corn Belt have soil that is neutral or at least is not acid enough to prevent the successful growth of sweetclover. This is particularly true of northeastern Kansas, eastern Nebraska, southeastern South Dakota, southwestern Minnesota, the river-bottom lands of northwestern Missouri, and a large share of the western part of Iowa. It is true, but to a lesser extent, of parts of Illinois, Indiana, and Ohio.

Except in localities in which the soil is known to be neutral or alkaline, tests should always be made to determine the lime requirement before attempting to grow the crop. Most county agents are equipped to make these soil tests or can advise how to make them. If the test shows an acid condition of the soil it is unwise to try to grow sweetclover without first applying lime to correct the acidity. It may not always be necessary to neutralize an acid soil completely, but sweetclover must have some lime if it is to be grown successfully. This necessity of liming presents a serious problem in many sections for under most conditions liming is expensive because of the cost of lime and the labor of hauling and spreading. But many Corn Belt farmers find that the expense of liming is more than offset by the extra returns from crops following sweetclover.

In a study of liming costs on 31 Corn Belt farms made before this bulletin was first issued, the quantity of lime used per acre ranged from 1 to 3½ tons, the average application being 2.73 tons per acre. The cost of lime varied from \$1 to \$5.25 per ton. Labor required for hauling and spreading varied considerably according to the distance of the haul and the method of spreading, the average requirement being 4.4 man-hours and 8.2 horse-hours per acre, or 1.6 man-hours and 3 horse-hours per ton. On most of these farms a conservative program was followed, and the lime was applied in late summer or

<sup>3</sup> Acknowledgment is made to the numerous farmers from whom data were secured, to the county agricultural agents for valuable assistance in making contacts with sweetclover growers in the various sections, and to college and experiment station officials in the Corn Belt States for helpful suggestions relative to this study.

fall to land that was to be seeded to sweetclover in the regular rotation the following spring.

More recently farmers in some localities have been able to obtain lime, ground, delivered, and spread from the truck as cheaply as \$1.35 to \$2 a ton. Few farmers, however, can afford to lime the entire farm in one year or even in one rotation period. Testing the soil for acidity may enable the farmer to cover more acres with the amount of lime purchased. On many moderately acid soils the use of 300 to 700 pounds per acre of finely ground limestone, 75 percent of which will pass through a sieve with 100 meshes to the inch, when mixed with the seed, has given good stands of sweetclover.

#### INOCULATION

Inoculation is important. In the soils of some sections, particularly in the western and northwestern parts of the Corn Belt, the required bacteria are already present, but unless this fact has been fully determined inoculation of the seed or soil is advisable before sweetclover is sown for the first time. Sweetclover and alfalfa are inoculated by the same strain of bacteria, and wherever sweetclover is planted following a successful alfalfa crop inoculation is unnecessary.

In most States, inoculating material may be obtained through the county agent, from the State experiment station, or from reliable seed dealers, at a cost of only a few cents per acre. On 30 farms inoculating costs averaged 8.9 cents per acre where culture was used, and 4.3 cents per acre where soil was used. Some farmers make a practice of inoculating their sweetclover seed each year, believing that they cannot afford to risk failure or a poor stand when the cost is so small.

#### SEEDING PRACTICES

In the Corn Belt practically all sweetclover is seeded with small grain. About three-fourths of it is seeded in spring grain—oats, barley, or flax—and nearly one-fourth in winter wheat. A few farmers make a practice of seeding sweetclover alone or in corn at the last cultivation, but as a rule these methods are followed only if some unusual condition prevails. The acreage seeded by these methods is comparatively small, and when sweetclover is seeded with corn usually the sweetclover is not successful.

If seeded with spring grain, the sweetclover is commonly sown with the grass-seeder attachment on the drill. This is the easiest and the most economical method of seeding as only a little additional labor is required. In some sections the usual practice is to mix the sweetclover seed thoroughly with the grain in the seeder box and drill them in together. However, if this method is followed, much of the seed is planted so deep that the stand is likely to be thin. If oats are disked in, on cornstalk land, the sweetclover is usually broadcast with an endgate or hand seeder after the oats are sown.

The most usual method of seeding sweetclover with winter wheat is to broadcast the sweetclover seed between late January and early March and let the action of the frost cover the seed. Or the seed may be broadcast in late March or April and covered with a light harrow or cultipacker. Still another method is to drill the sweetclover seed in the wheat the latter part of April. Seeding sweetclover

in small grain is not only economical of labor but permits a more effective utilization of land.

In sections in which the soil is unusually fertile and in sections in which clover has been grown for several years, the plant frequently grows so rank as to be troublesome in the grain at harvest-time. Under such conditions it is well to delay sowing sweetclover until 2 or 3 weeks after seeding the spring grain. Then the seed is usually put in with a grain drill or is sown broadcast and covered with a harrow, or cultipacker.

Late-summer seeding is seldom practiced, although it is as likely to be successful, as is late-summer seeding of alfalfa. It is more expensive and does not result in as strong and vigorous first-year growth as spring seeding. The practice has little to commend it except where spring seeding has failed, or where sweetclover is sown as a catch crop. A farmer in Nebraska has obtained satisfactory results by seeding sweetclover in small-grain stubble. At harvest-time a double disk, a grain drill with sweetclover seed in the grass-seeder attachment, and a smoothing harrow are hooked behind the binder and the whole outfit is drawn with a tractor. By this method the grain is harvested and sweetclover sown at one operation.

In the drier sections of the western part of the Corn Belt numerous failures result from seeding sweetclover with small grain. The grain crop seriously competes with the clover for moisture. Where this condition prevails seeding sweetclover alone usually brings better results.

Practically all commercial sweetclover seed is now scarified. Scarified seed germinates quickly and is best for late spring or summer planting. For very early spring or late winter planting scarified seed is less desirable because it is likely to germinate during a brief period of warm weather, only to have the seedlings killed by a subsequent freeze. An increasing practice, particularly in the eastern part of the Corn Belt, is to sow unhulled and unscarified seed on winter wheat in January and February. In the eastern part of the Corn Belt this is one of the most reliable methods of obtaining a stand.

The quantity of seed sown per acre varies from 4 to 25 pounds, the average being 12 pounds. Heavier seedings are usually made when the crop is to be used for pasture or hay and lighter seedings when a seed crop is to be harvested. In some of the more fertile sections, and where sweetclover has been rotated over the entire farm, 4 pounds per acre is enough. Where unhulled seed is used the rate of seeding is usually a third heavier.

#### SWEETCLOVER IN MIXTURES

The practice of seeding other clovers and grasses with sweetclover is gaining favor in many sections. Several advantages are claimed for this method. In sections in which a lack of lime in small areas prevents an even stand of sweetclover over the entire field the other plants will fill in the skips. The presence of the other plants gives variety to the diet of feeding animals, lessens the danger of bloat, helps to bridge over the gap that may occur between the grazing season of second-year and first-year sweetclover, and lengthens the grazing season if the pasture is grazed through the fall of the second

year. On soils that heave badly in winter the grass roots tend to protect the sweetclover and lessen the damage to the stand. A further advantage in sections that have a loose, porous soil is that the grasses form a sod that permits a better job of plowing in the fall after the pasture season is over.

#### SEEDING SWEETCLOVER IN PERMANENT PASTURE

Many Corn Belt farmers wish to use sweetclover as a permanent pasture either in a pure stand or mixed with grass. This is especially true on farms on which rough unplowable land is devoted to grazing. This has been done successfully, but the failures to secure and maintain permanent stands of sweetclover far outnumber the successes. The most common causes of failure are acid soil and wrong seeding methods.

In most old fields the soil is sour so lime must be added. Limestone may be broadcast or drilled in. Drilling is preferable as it places the lime where it will be most effective. Finely ground limestone should be used with either method of application, to obtain best results. The drilling of finely ground limestone mixed with sweetclover seed increases the chances of obtaining a stand.

On farms so fortunately situated as not to need lime it is possible to obtain a very good stand. The only requirement is to provide a surface of bare, loose soil upon which the seed may fall and germinate. If the old sod is not too thick this may be done by disking or harrowing early in spring, scattering the seed upon the fresh soil, and covering it by rolling or light harrowing. A rather heavy seeding is advisable in such cases. If the sod is thick, with a heavy accumulation of old grass, the field should be burned off late in winter when the grass is dry and the seed disked in or allowed to be covered by the action of frost. It is almost a waste of seed to sow sweetclover on heavy sod without some previous preparation. Most of the seed lodges on the grass, or, if it happens to touch bare soil, it germinates but does not take root. The result is a few widely scattered plants too separated to be of any value.

For permanent pasture a mixture of grasses with sweetclover is usually better than sweetclover alone. Timothy and bluegrass, and in the southern part of the Corn Belt, orchard grass, make good combinations with sweetclover. In localities in which bluegrass comes in readily, this grass may be omitted from the seed mixture, and allowed to come in of its own accord.

Soil of old fields is usually deficient in the bacteria that inoculate sweetclover roots, and these must be supplied by artificial inoculation. The double-culture method, whereby both soil and laboratory inoculating material are used, gives assurance of inoculation.

If a new pasture is made by seeding a mixture of sweetclover and grasses, it may be pastured lightly the first year, but sweetclover in an old bluegrass pasture should not be grazed the first year. For this reason it is advisable, in old pastures, to seed half of the pasture to sweetclover one year and the other half the next year. The first year's seeding may then be grazed the second year and the second year's seeding grazed the third year. In mixtures of sweetclover and bluegrass, there is a tendency for the bluegrass to increase as it does in an alfalfa field, and crowd out the sweetclover in 3 or 4 years.



In some sections, particularly in the western part of the Corn Belt, sweetclover may be handled as a permanent pasture, but it should be tried on a small scale until proved to be successful.

An example of sweetclover being successfully established as a permanent pasture is furnished by a dairy farmer in Lancaster County, Nebr. On this farm, half of a 25-acre native pasture was broken up and seeded with  $1\frac{1}{2}$  bushels of oats and 13 pounds of white biennial sweetclover seed per acre in March 1922. Both oats and sweetclover were grazed from June 15 to October 31, care being taken not to have the sweetclover grazed too closely. On March 20 the following spring the field was reseeded with sweetclover at the rate of 9 pounds of seed to the acre. That year the field was pastured from the first week in May until freezing weather in the fall, but enough of the second-year sweetclover matured to reseed the field. In 1925 the other half of the field was seeded in the same way. Four years later the 25 acres were furnishing ample grazing for 13 to 15 cows and between 25 and 30 head of young cattle from about April 20 to late fall.

The sweetclover reseeds each year, so there was a good stand of both first-year and second-year plants from early spring until the last of August, and no break in the pasture season. The fore part of the season the cattle grazed mostly on the second-year plants, gradually shifting to the new seeding as the older plants become larger and more fibrous. Bluegrass began to come in, thus threatening to crowd out the sweetclover.

On a neighboring farm a combination of sweetclover and brome-grass (*Bromus inermis*) was established as a permanent pasture on 8 acres of land. This was seeded in 1925 with 10 pounds of sweetclover and 25 pounds of brome-grass seed to the acre. It was grazed lightly in the fall of the first year and spring of the second year, and then allowed to mature seed. After that the sweetclover reseeded each year, and the combination made an excellent pasture.

#### UTILIZATION OF SWEETCLOVER

One of the principal purposes in growing this crop is to restore or increase soil fertility, but on most farms the crop also serves from one to several other purposes. It is used for hay, pasture, and as a seed crop. Among 203 Corn Belt farms on which sweetclover occupied an important place in the cropping system, 27 farms were growing the crop for soil improvement alone. On the other 176 farms, in addition to being grown for soil improvement, the crop was used for pasture on 149 farms, for hay only on 16 farms, for seed only on 7 farms, and for both hay and seed on 4 farms. Of the 149 farms using sweetclover for pasture, 92 were using the crop for pasture alone, 32 were also using it for hay, 13 for seed, and 12 for hay and seed. The greatest benefits are derived when sweetclover is used for pasture as well as for soil improvement.

#### SWEETCLOVER FOR PASTURE

On most Corn Belt farms some kind of livestock production is important, and in those sections in which sweetclover is grown it is of outstanding value as a pasture. As a rule it will carry two or more times as many animals per acre as will bluegrass so that its use means a reduction in the acreage required for pasture. This is an important

consideration on most Corn Belt farms. All classes of livestock are grazed on sweetclover, but it is more generally used as a pasture for dairy cattle than for other farm animals. Most of the sweetclover used for pasture is grown in the crop rotation, and grazing practices vary considerably between different sections, as well as between individual farms in the same section. Some farmers make a practice of grazing the first-year crop for 2 to 3 months and the second-year crop from early spring until it matures. Others graze the first-year crop in the fall and the second-year crop only until it is plowed under for corn. Still others do not graze the first-year crop, but make full use of the second-year crop. On a few farms sweetclover for pasture is not grown in the regular rotation but on land that is permanently devoted to pasture.

If sweetclover is seeded in small grain in the spring, the first year's growth may be grazed lightly for 60 to 75 days in the fall. First-year sweetclover does not become tough and woody and is relished by all kinds of livestock. Under favorable conditions second-year sweetclover can be pastured considerably earlier in the spring than any of the other pasture crops now in common use, with the possible exception of bluegrass. However, the stand may be injured from grazing too early when the ground is muddy. The plants grow very rapidly in the spring, and to maintain a good quality of pasture during the spring and summer a sufficient number of livestock should be carried to keep the growth from becoming too rank. One of the principal difficulties in pasturing the second-year crop comes from permitting it to become woody and tough, especially when it is used for hog pasture. Cattle and horses eat the rank growth better than hogs do, but even for these kinds of livestock the growth must be kept down if best results are to be obtained. If the second-year crop grows too high, it should be clipped to keep it back and to bring out the new shoots. In clipping with a mower the cutter bar should be set high enough so the plants will be cut above the lower branches. Farmers who are making the most effective use of sweetclover pasture adjust their acreage of the second-year crop to meet the requirements of the livestock to be pastured, or they adjust the number of livestock to the amount of pasture available.

#### CARRYING CAPACITY

When pastured to its full capacity a good stand of sweetclover will carry from one to two animal units to the acre through the fall grazing period without being injured.<sup>4</sup> It is not advisable to pasture it to its full capacity the first year. On many farms it is usual to seed sweetclover in all small grain and to pasture the entire seeding in the fall. Under these conditions the farm livestock will frequently have the range of a considerable acreage of sweetclover that was sown primarily for soil improvement. Second-year sweetclover will furnish more grazing than any other pasture crop common to the Corn Belt. When grazed to its maximum carrying capacity it will carry from two to three animal units to the acre (table 1), and cases are on record in which as many as four animal units have been pastured to the acre for a period of from 100 to 110 days.

<sup>4</sup> An animal unit is 1 horse, mule, or cow; or 2 yearlings; or 4 calves or colts; or 5 hogs; or 10 pigs; or 7 sheep or goats; or 14 lambs or kids.

TABLE 1.—*Sweetclover pasture: Farms making most effective use of second-year sweetclover pasture*

State	Acres pastured	Grazing period		Days pastured	Total animal units	Animal units per acre	Total animal- unit days	Animal- unit days per acre
		From—	To—					
Michigan.....	9	May 15	Aug. 15	92	24.6	2.73	2,263	251
Do.....	4.5	Apr. 20	July 30	101	16.4	3.64	1,656	368
Wisconsin.....	7	June 1	Aug. 30	90	20.0	2.86	1,800	257
Do.....	6	May 15	Aug. 15	92	16.0	2.67	1,472	246
Do.....	6	Apr. 15	do.....	122	17.0	2.83	2,074	345
Illinois.....	12	May 15	do.....	92	30.0	2.50	2,760	230
Do.....	25	May 1	Aug. 30	121	60.0	2.40	7,260	290
Do.....	35	do.....	do.....	121	70.0	2.00	8,470	242
Minnesota.....	40	May 15	Aug. 15	92	140.0	3.50	12,880	322
Do.....	10	May 1	do.....	106	20.0	2.00	2,120	212
Do.....	15	Apr. 15	Aug. 30	137	32.5	2.17	4,453	297
Do.....	15	May 10	do.....	112	39.0	2.60	4,368	291
Do.....	12	do.....	do.....	112	25.0	2.08	2,800	233
Do.....	9	Apr. 25	Aug. 20	117	18.0	2.00	2,106	234
Iowa.....	15	May 7	Aug. 15	100	42.0	2.80	4,200	280
Do.....	10	do.....	do.....	100	20.8	2.08	2,080	208
Do.....	150	Apr. 20	do.....	117	316.0	2.11	36,972	247
Do.....	5	May 1	do.....	106	14.0	2.80	1,484	297
Missouri.....	12	Apr. 1	do.....	136	25.0	2.08	3,400	283
Do.....	22	May 3	Aug. 31	120	60.0	2.72	7,200	327
South Dakota.....	10	May 1	Aug. 30	121	20.5	2.05	2,481	248
Do.....	60	do.....	do.....	121	180.0	3.00	21,780	363
Nebraska.....	15	Apr. 15	July 25	101	30.0	2.00	3,030	202
Total.....	504.5			2,529	1,236.8		139,109	
Average.....		May 1	Aug. 20	111		2.45		276

The problem of having continuous sweetclover pasture is of much concern to many farmers. With the biennial white the usual grazing period of the second-year crop is from the latter part of April or the first of May to August 15 to 30, for the first-year crop it is from about August 15 to 30 until freezing weather. It would seem, therefore, that there is an overlapping of the grazing periods of the two crops. However, under conditions of dry weather a gap of from 10 to 20 days is likely to occur between the end of the grazing period of second-year sweetclover and the beginning of the grazing period the new spring seeding. Unless extreme drought prevails this period of shortage may be avoided by using late-maturing varieties. Under normal conditions spring seedlings are large enough to graze by the middle of July or the first of August, but it is not always a good plan to pasture it as early as this if maximum benefits are to be gained from the crop the following year. Light grazing may do no damage, but heavy grazing early in the fall is likely to injure seriously the development of the crop the following spring.

A growing practice is to seed all small grain to sweetclover, let the livestock graze over the entire seeding from the middle of August until freezing weather, and the following spring set aside enough acreage to provide the pasture required to carry the livestock through the grazing period of the second-year crop. Under these conditions the new seeding is not grazed heavily enough to seriously retard its development, and a continuous pasture is provided throughout the growing season. If a relatively small acreage of sweetclover is grown, the possibility of midsummer pasture shortage is avoided by planting a small acreage of Sudan grass to provide grazing from the time the second-year sweetclover matures until it is safe to pasture the new seeding. On some farms a reserve bluegrass pasture is used to fill in this gap.

## FOR DAIRY COWS

Sweetclover is exceptionally valuable as a pasture for dairy cows. It not only furnishes more feed per acre than does any other pasture, but also provides an abundance of succulent pasture during the hot, midsummer months, when bluegrass and other pasture is usually unproductive and dairy cows generally suffer from lack of feed. Dairy-men who have used sweetclover agree that cows maintain a better flow of milk on this pasture than on any other grazing crop common to the region (fig. 1).

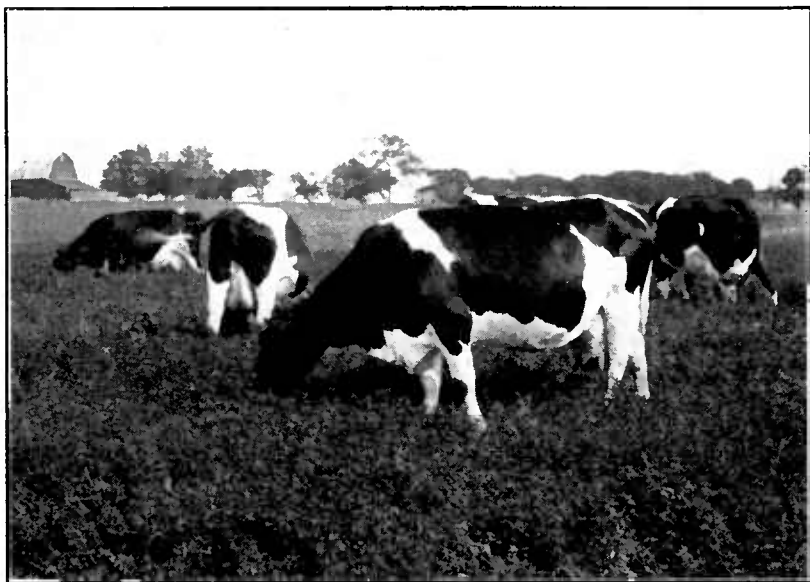


FIGURE 1.—Dairy cows maintain a heavy flow of milk on sweetclover pasture, and a good stand like this will furnish grazing for two to three cows per acre for 100 to 110 days.

An example of the value of this pasture for dairy cows is furnished by the St. Francois County Dairy Herd-Improvement Association of Missouri. For the testing year 1928-29 the association included 345 cows, which averaged 278.2 pounds of butterfat per cow, with an average feed cost of \$66.90, and an income above feed cost of \$90.02 per cow. The winter feed was practically the same for all herds, but four herds, with 45.45 cow-years, were pastured on sweetclover during the summer months. These four herds averaged 305.23 pounds of butterfat per cow for the year, at a feed cost of \$69.05, and an income above feed cost of \$107.32 per cow, or \$17.30 per cow above the average for all cows in the association. These four herds, with practically the same cows, were in the test in 1927-28 but did not have sweetclover pasture. Their average butterfat production per cow that year was 282 pounds.

## FOR BEEF CATTLE

Sweetclover makes excellent pasture for beef cows and calves (fig. 2). However, the claim is sometimes made that beef cattle do

not make satisfactory gains on sweetclover pasture alone. This may be true if the plants are allowed to become coarse and woody before the cattle are turned on the pasture, but there are numerous cases on record of steers that have put on gains of 2 pounds or more per day on sweetclover pasture alone. It is obvious, however, that the most satisfactory gains are made when the sweetclover pasture is supplemented with a grain ration. A rather outstanding example of this is the case of a baby-beef producer in Cottonwood County, Minn., who pastured on sweetclover exclusively. His practice was to buy calves weighing from 550 to 600 pounds, pasture them on sweetclover for about 75 days, and finish them in the dry lot. The pasture



FIGURE 2.—Beef cows and calves on closely grazed sweetclover. Because of its milk-producing qualities sweetclover provides excellent grazing for beef cows with suckling calves.

was supplemented with corn. The following is a record of 1 year's results:

The last of May 1928, 56 Hereford calves were bought at Milford, Iowa. These calves had been shipped from the sand hills of Nebraska and had been on pasture for a week, so probably had recovered shipping shrinkage. They were weighed at Milford, averaging 586 pounds each, hauled by truck to the farm, a distance of 60 miles, and turned on a 35-acre sweetclover pasture. They were on pasture from June 1 to August 15, a period of 75 days, and then put in the dry feed lot. When taken off pasture they averaged 848 pounds, having made a gain of 262 pounds each, or  $3\frac{1}{2}$  pounds per head per day for 75 days. The total gain for the 56 head was 14,672 pounds. While on pasture they were fed 42,000 pounds of corn in self-feeders. Thus, the quantity of corn required for 1 pound of gain while on pasture was 2.86 pounds.

In addition to the 56 beef cattle, 15 dairy cows were also pastured on the 35 acres of sweetclover.

An example of a different system is that of a cattle feeder of Woodbury County, Iowa, who annually fed out from 175 to 250 steers, and

about 200 hogs, and depended entirely on oats and sweetclover for pasture. His cropping system was as follows:

First year.....	Oats and sweetclover pasture.
Second year.....	Sweetclover pasture.
Third year.....	Corn for grain and silage.

From 120 to 160 acres were sown to oats and sweetclover each year. The first year the combination was grazed from about May 1 until freezing weather, and the second year the sweetclover was grazed from about April 1 until the latter part of August.

Calves from 4 to 6 months old, weighing approximately 325 to 350 pounds were bought in the spring and pastured on the oats and sweetclover through the summer and fall of the first year. Usually part of the calf herd was put on heavy grain feed and finished off as baby beef in the fall of the first year. The remainder were wintered in stalk fields and on alfalfa hay and silage and turned on the second-year sweetclover as soon as it began growth in the spring. The cattle had no other pasture but were fed corn throughout the year. Those carried through the second year were put on full-grain ration during the last 4 to 6 weeks of the pasture period. Hogs followed the steers the second year.

#### FOR HOGS

First-year sweetclover makes an excellent pasture for hogs, as does the second-year crop when it is closely grazed and not allowed to get too rank and woody. According to the South Dakota Experiment Station Extension Circular 258, Sweet Clover for Profit:

It is especially useful in a 3-year rotation to provide clean pasture as well as green feed for pigs to prevent losses from roundworms, necrotic enteritis, and other similar parasitic and filth-born diseases.

The following experience of a Missouri farmer although outstanding as to results, indicates the general possibilities of the crop for hog pasture.

On May 1, 1929, 323 head of hogs, weighing 32,525 pounds, were turned on a 40-acre sweetclover pasture. They were left on pasture for 30 days and during this time were fed 750 bushels of corn. When taken off pasture on May 31 they weighed 45,250 pounds, having made a total gain of 12,725 pounds in 30 days. The quantity of corn required per pound of gain while on sweetclover pasture was 3.3 pounds.

#### FOR SHEEP

Sheep feeders generally report both first-year and second-year sweetclover as superior to other clover or bluegrass as a pasture for sheep. A good stand will carry from 15 to 20 head to the acre. Sheep graze closely and keep the second-year crop down so that the growth is fresh and tender. The pasture, either alone or supplemented with a grain ration, is used with excellent results for fattening lambs. Sheep are less likely to bloat while pasturing on sweetclover than on white, red, or alsike clover.

#### BLOAT FROM PASTURING ON SWEETCLOVER

Numerous instances of cattle bloating from pasturing on sweetclover have been reported, but the danger is less than when alfalfa, red clover, or alsike clover is pastured. Where this is a relatively new pasture crop, livestock ailments resulting from other causes are sometimes attributed to sweetclover. In several instances fatal

cases of reported bloat from sweetclover have turned out to be something entirely different when properly diagnosed. But there is some danger of bloat, and precautions should be taken to guard against it.

Bloating occurs most frequently in May and June, and is due principally to animals gorging themselves on green succulent forage. The best preventive is to make sure that the animals are not hungry when turned into a sweetclover field. While they are on the field they should have free access to a pile of hay or straw or to some mature grass that satisfies their craving for dry feed and prevents their overeating on the sweetclover. In districts that have soft water it is well to add lime or a good mineral mixture to the drinking water. Even with these precautions a close watch should be kept on the animals during the seasons of rapid plant growth. Animals that show signs of distress should be given immediate treatment with a trocar, a knife, or a vomiting agent.

#### **SWEETCLOVER AS A SOILING CROP**

Sweetclover is a valuable soiling crop on dairy farms that are adapted to this method of feeding. A South Dakota dairy company that operated three farms used second-year sweetclover as a soiling crop exclusively on one farm, and as pasture on the other two farms. For soiling purposes cutting sweetclover began on this farm when the plants attained a height of 12 to 15 inches, and continued each day as long as the clover lasted. As soon as it was cut the green sweetclover was loaded into a feed rack mounted on a wagon and hauled to the feed lot. Two and sometimes three cuttings were obtained during the season. The manager stated that sweetclover handled in this way provided twice as much feed per acre as when pastured and that for highly specialized dairy farms this method of feeding the crop was more satisfactory than pasturing.

#### **SWEETCLOVER FOR BEES**

Sweetclover was first used by beekeepers, who sowed the seed in waste places and along the roadsides to provide a honey crop for their bees. The crop is now regarded as one of the best plants for honey production. The quantity of honey produced is large and the quality excellent. The blooming season is long, and the period of nectar secretion usually follows that of red, white, and alsike clover. By sowing both early- and late-maturing varieties and Hubam, bee pasture can be provided from June until late in the fall.

#### **SWEETCLOVER FOR SOIL IMPROVEMENT**

Corn Belt farmers generally recognize the effectiveness of sweetclover in restoring soil fertility and increasing crop yields, and estimates of increases of from 10 to 25 bushels of corn to the acre from plowing under a single crop, or from the use of the crop through one or two rotation periods, are not unusual.

Comparatively few farmers keep accurate record of crop yields, but in 1929 data were obtained from 63 farms on which records had been kept of actual measured yields of corn following sweetclover as compared with the yields obtained in the same field previous to using sweetclover or with yields in a part of the same field when corn

followed corn or a small-grain crop on land that had never been in sweetclover.

These 63 farms represent two different cropping systems. In one the second-year sweetclover was plowed under as a green-manure crop, and in the other the sweetclover was pastured, or cut for hay, or harvested for seed, or allowed to mature before being plowed under (table 2).

TABLE 2.—*The effect of sweetclover on corn yields*

Method and soil	Farms report- ing	Average yield of corn		Increased yield per acre due to using sweetclover	
		After sweet- clover	No sweet- clover		
Sweetclover plowed under green:	<i>Number</i>	<i>Bushels</i>	<i>Bushels</i>	<i>Bushels</i>	<i>Percent</i>
Poor to medium soil.....	11	51	31	20	64
Soil in good tilth.....	14	60	44	16	36
Total or average.....	25	56	38	18	47
Sweetclover plowed under after maturing:					
Poor to medium soil.....	18	56	26	30	115
Soil in good tilth.....	20	63	46	17	37
Total or average.....	38	60	37	23	62

Figures from the different farms are not strictly comparable because on some farms the yield of corn produced in the field previous to seeding it to sweetclover was taken as the check, or basic yield; consequently a part of the recorded increase may have been the result of seasonal variation in yield. On other farms the yield of corn following corn or small grain in a part of the same field or in a similar field is taken as the basis of comparison with the yield of corn after sweetclover. In the latter case the results should be more nearly comparable as the yields are of the same year. They may have been influenced to some extent by some slight variation in soil fertility, although as a rule the sweetclover was seeded on land that averaged as low as or lower than that in the check field in productivity.

The farms on which sweetclover was plowed under as a green-manure crop were divided into two groups according to the yield of corn in the check fields (table 2). On the farms in the first group, yields in the check fields averaged 31 bushels to the acre. Yields following sweetclover averaged 51 bushels to the acre, an increase of 20 bushels to the acre. On the farms in the second group, yields in the check fields averaged 44 bushels to the acre, and the yield following sweetclover was 60 bushels to the acre, an increase of 16 bushels to the acre. The average yield on the check fields of the 25 farms of both groups was 38 bushels to the acre, and following sweetclover it was 56 bushels, an increase of 18 bushels to the acre.

The farms on which corn followed second-year sweetclover that had been used for pasture, or harvested for hay or seed, or allowed to mature before being plowed under, were also divided into two groups. On the farms in the first group, yields in the check fields averaged 26 bushels to the acre, and the yield following sweetclover was 56 bushels, an increase of 30 bushels to the acre. On several farms in this group



the sweetclover had been seeded on land on which long-continued cropping to corn or alternating crops of corn and small grain had reduced yields to a low level. On the farms in the second group the check yields averaged 46 bushels to the acre, and the yields following sweetclover averaged 63 bushels, a gain of 17 bushels to the acre. The average yield on the check fields for the 38 farms of both groups averaged 37 bushels to the acre and the yield following sweetclover averaged 60 bushels, a gain of 23 bushels to the acre.

Records from several farms, on which sweetclover had been used in the regular cropping system for a period of several years show corn yields to have been increased from an average of 42 bushels to the acre before the use, to an average of 68 bushels to the acre after this crop had been used through three rotation periods.

Increase in winter wheat yields resulting from the use of sweetclover are even more striking than those for corn. Data were obtained from 14 farms on the comparative yields of wheat following sweetclover and of wheat following corn or a small-grain crop. On seven of these farms winter wheat followed a spring seeding of sweetclover that was plowed under in August. The basic yield on these farms was 14.7 bushels to the acre, and the yield following sweetclover was 26.8 bushels, an increase of 12.1 bushels, or a gain of more than 82 percent. On the other seven farms winter wheat followed second-year sweetclover that, in most cases, had been pastured or allowed to mature before being plowed under. On these farms the basic yield was 11.86 bushels to the acre, and following sweetclover the yield was 32.28 bushels, an increase of 20.42 bushels to the acre, or a gain of 172 percent.

Records from a few farms on which wheat followed oats or barley in a regular rotation of corn, spring grain, winter wheat, and sweetclover showed wheat yields to have been increased from an average of 17 bushels per acre to 38 bushels by the use of sweetclover through three rotation periods.

The most striking results were obtained on land that originally was highly productive but that had been reduced to a relatively low level of productivity by a system of farming that had depleted the soil of organic matter and nitrogen. Proportionate increases in yields cannot be expected on land that is already highly productive. Moreover, in many instances the farmer was led to record the comparative yields simply because of the striking difference that was evident, whereas when the difference was less apparent no record of yields was kept. As a result, the records obtainable probably represent extreme cases, and the increased yields are considerably larger than the average.

Nor can it be assumed in all instances that the increased crop production was entirely due to sweetclover. On a few farms the land in sweetclover had been limed in preparation for that crop, and this in itself may have had an influence on the succeeding crop. In other instances it appears that the land in sweetclover was given better preparation than that in the check fields. This is particularly true in the case of wheat and where this crop followed second-year sweetclover. But, even with due allowance being made for all these considerations, the results are convincing as to the outstanding value of the crop as an economical and effective means of maintaining production at a high level.

Best results are secured where a green-manure crop of sweetclover is supplemented with an application of superphosphate. The experience of a farmer in Nodaway County, Mo., furnishes an unusual example. After two failures to get a stand without liming, a 20-acre field was limed at the rate of 2.5 tons of ground limestone to the acre in the summer of 1926. The lime cost \$2 per ton, and the labor of hauling and spreading cost \$2.50 per acre, making the total liming cost \$7.50 per acre. The field was sown to winter wheat and in April 1927, inoculated sweetclover seed was sown on the wheat at the rate of 15 pounds to the acre. The cost of seed, inoculation, and labor of seeding the sweetclover was \$1.57 per acre. After wheat harvest, 16 dairy cows and 135 hogs were pastured on the 20 acres of sweetclover from July 7 to October 31. Early in May 1928, the sweetclover was plowed under and the land was double disked, cultipacked, harrowed, and planted to corn. An application of 200 pounds to the acre of 20-percent superphosphate was made just before the corn was planted, and unfertilized strips were left for checks. The superphosphate cost \$2.85 per acre. The unfertilized check strips averaged 80.57 bushels of corn to the acre, and the fertilized land 98.28 bushels. The three previous crops of corn on this field averaged 42 bushels to the acre. On this basis lime and sweetclover increased the corn yield 38.57 bushels to the acre above the previous average, and the application of 200 pounds of superphosphate resulted in a further increase of 17.71 bushels to the acre.

The increased yield of corn more than paid the total cost of liming, of seeding to sweetclover, and of the superphosphate. This is an unusual case, but though obviously much greater than can be expected under average conditions, the results emphasize the possibilities of an effective use of lime, sweetclover, and superphosphate in economical corn production.

#### SWEETCLOVER FOR HAY

Both first-year and second-year crops are utilized for hay. The second year's crop is used for hay mostly in southeastern South Dakota, southern Minnesota, and the northern third of Iowa, where the first year's growth seldom grows large enough to cut for hay. Sweetclover hay is put up mostly for home use, but in some sections more or less sweetclover hay is sold locally, principally to cattle feeders.

The fall crop of the first year makes the better-quality hay. It is leafier, is finer-stemmed, and by many feeders is regarded as practically the equal of alfalfa in feeding value. In some sections it is replacing alfalfa as a hay crop. On farms on which a considerable acreage is sown for pasture or for soil improvement, enough of the first-year crop to supply the farm needs for hay can usually be cut. Moreover, it is harvested at a time when it does not seriously compete with other crops in the use of labor, which is not the case with alfalfa (fig. 3). Hay from first-year sweetclover is likely to be mixed with more or less stubble from the grain crop in which it was sown, but this is not a serious objection if it is for home use. The first year's crop is usually harvested in the same way as alfalfa.

Second-year sweetclover is coarser and much more difficult to save in good condition than is the first year's growth. When cut before any blossoms appear, and cured in good condition, it makes a fairly satisfactory hay; but if for any reason the cutting is delayed the hay

is likely to be coarse, woody, and of relatively poor quality. Some of the fine-stemmed varieties, however, make hay of fairly good quality



FIGURE 3.—The first-year crop of sweetclover may be cut for hay just before corn husking. At this time of the year haying does not compete seriously with other farm work.



FIGURE 4.—Some of the fine-stemmed varieties of sweetclover make fairly good hay even when cutting is delayed until after blooming has begun.

even when partly in bloom (fig. 4). Two general methods are followed in harvesting second-year sweetclover for hay. One is to cut the hay

with a mower having the cutter bar set as high as possible and rake into windrows with a side-delivery rake as soon as wilted. The windrows are turned from one to three times, depending on the weather. When thoroughly cured, the hay is put in stacks with buck rakes and a stacker. Another method, and one which has been more generally followed, is to cut with a binder. The bundles are set up six to eight to the shock, and are stacked when thoroughly cured. This method is dangerous, however, as it provides favorable conditions for the spoilage of the hay before it is cured.

Yields of the hay vary considerably. Yields on 31 farms on which first-year sweetclover was cut for hay ranged from three-fourths of a ton to 1.4 tons to the acre, the average being 1.2 tons. Yields reported from 29 farms on which the second-year crop was cut for hay ranged from three-fourths of a ton to 2.7 tons to the acre, the average being 1.5 tons per acre.

#### DANGER FROM SWEETCLOVER HAY

Farmers in the Corn Belt have learned to be cautious in feeding hay made from second-year sweetclover because of occasional outbreaks of a strange disease following its use. The disease, which occurs more commonly in young cattle, manifests itself by loss of clotting power of the blood, the afflicted animals bleeding to death from minor wounds or from internal hemorrhage. The cause of the disease is related to a chemical break-down in the cumarin content of the plant brought about by fermentation when spoiling. Often the spoilage is not visible, and every precaution should be taken in curing the hay to prevent any heating. A development of cumarin-free varieties will eliminate this hazard, but so far these varieties have not been found.

Sweetclover disease is most likely to occur when hay is fed exclusively, for a considerable time. Supplementing the hay with other roughage and changing the feed every 3 or 4 weeks usually seems to prevent the trouble, although it has been known to occur from feeding a mixed hay containing sweetclover.

#### SEED PRODUCTION

Because of the uncertainty of yield, difficulty of harvesting, and the relatively low price of seed, the production of sweetclover seed is not generally regarded as a dependable enterprise for the Corn Belt proper. Many farmers who formerly made a regular practice of saving a seed crop now obtain their seed supply from sections in which seed production is a specialty. As a result of this situation much of the sweetclover seed sold on the market is of the early-maturing varieties producing lower yield and shorter periods for grazing than the late-maturing ones. Farmers often may save enough seed for their own needs from their pasture, or from the second growth after a cutting of hay has been made from second-year sweetclover. Others obtain their seed supply from volunteer plants in their small grain, the sweetclover seed being screened out of the grain at threshing time.

When sweetclover is grown for seed the most common method of harvesting the crop is with an ordinary grain binder, although the combine is now being successfully used in many sections. When it is harvested with a binder the bundles are shocked like small grain

or left on the stubble until dry enough to thresh. Some thresh out of the field, and others stack the bundles and thresh later (fig. 5). The threshing is usually done with an ordinary grain separator equipped with special clover screens or a huller attachment.

The tall-growing white biennial varieties, because of their large growth, are difficult to harvest with a binder but have been successfully handled with a combine harvester. Regardless of the method of harvesting, however, better results are obtained if the early growth of the second year is pastured, cut for hay, or clipped and left on the



FIGURE 5.—A crop of sweetclover harvested for seed, stacked, and ready for threshing.

ground. This will insure more uniform ripening of seed and make the crop easier to handle with a binder.

Yields vary greatly, the acre yields reported for 1928 ranging from 30 to 450 pounds for common white biennial; from 120 to 540 pounds for Grundy County White; and from 35 to 495 pounds for yellow biennial.

#### PLOWING UNDER SWEETCLOVER

The time to plow under sweetclover is determined largely by the purpose for which it is grown or by the place it occupies in an established cropping system. If grown mainly for restoring the fertility of badly depleted soil, it is usually allowed to go to maturity before being plowed under. It may be utilized for pasture or hay or harvested for seed, or the entire growth may be plowed under (fig. 6). When handled in this way, it is plowed under in the fall of the second year or the spring following, depending on whether fall or spring plowing is the more desirable. If the crop is left to mature and no use is made of it the second year, the mass of dead vegetation may be difficult to plow under. In such cases it will be necessary to roll down and break up the dead stalks if a good job of plowing is to be

done. A cultipacker is probably the most effective implement for this work, but it must be used when the stalks are dry.

Sweetclover grown as a green-manure crop for corn is usually plowed under in the spring of the second year. From the standpoint of obtaining maximum fertilizing value it should be plowed under when the new growth is from 6 to 15 inches tall, for at this stage the maximum quantity of plant food is stored in the roots and stems. More organic matter is added to the soil by plowing the clover under later, but the quantity of nitrogen is not increased. Data from Ohio indicate that approximately 80 percent of the max-



FIGURE 6.—On soils that have been reduced in productivity through long-continued cropping the plowing-under of a crop of mature sweetclover like this has more than doubled the yield of the succeeding corn crop.

imum quantity of nitrogen is found in sweetclover about May 1. At this time the plants contain from 3 to 4 percent of nitrogen; in July they contain but 1.5 to 2 percent.<sup>5</sup>

Late plowing-under has other disadvantages. It is often difficult to turn under the heavy growth and do a good job of plowing. Moreover, the heavy growth is likely to deplete the soil moisture to the detriment of the succeeding crop. This is especially true in the western part of the Corn Belt.

If winter wheat follows a catch crop of sweetclover it is obvious that the latter must be plowed under early in the fall. Fall plowing of first-year sweetclover for corn is also desirable under certain conditions. In some sections corn succeeds better with fall plowing than on land plowed in the spring. Furthermore, if a considerable

<sup>5</sup> Ohio State University Extension Bulletin No. 55, Sweet Clover.

acreage is to be plowed under, too much work comes at one time if the plowing is left until spring.

Where these conditions prevail, farmers follow the practice of plowing under all or a part of their crop in the fall of the first year. But fall plowing first-year sweetclover has two real disadvantages. If the plowing is done late in the fall the fertilizing value will be nearly as great as if the clover had been plowed under in the spring, but the sweetclover is likely to come up and be troublesome in the succeeding crop unless the crowns are severed from the main root. This can be done with a plow equipped with special attachments.<sup>6</sup> If corn follows late fall-plowed sweetclover considerably more labor must be expended in the preparation and cultivation of the crop, and if the spring grain follows there is likely to be more sweetclover than grain. If the plowing is done early, say by the middle of September, there will be much less danger of the sweetclover volunteering enough the following spring to be troublesome, but the maximum quantity of nitrogen will not be obtained.

### SWEETCLOVER IN CORN BELT CROPPING SYSTEMS

Sweetclover has become a fixture in the cropping systems that prevail in many sections of the Corn Belt. The general characteristics of the plant have made it easy to dovetail sweetclover into most cropping systems common to various sections of the region. It fits readily into either short or long rotations and may be rotated over the entire farm in a comparatively short time. The type of farming, type of soil, length of growing season, and use to which sweetclover is put largely determine the place of this crop in Corn Belt cropping systems. On grain farms a small acreage will provide all the hay and pasture needed, thus leaving most of the crop to be plowed under for soil improvement. On combination grain and livestock farms the pasture requirements are greater, and the sweetclover is usually grazed through the second year and the residues plowed under for soil improvement.

The following rotations or cropping systems are now in common use in various parts of the Corn Belt. These cropping systems have been worked out by farmers to suit conditions generally prevailing in the different sections, and in each section individual farmers will be found who have worked out various modifications of the usual rotation to fit the conditions on their own farms.

### ROTATIONS FOR GRAIN FARMS WITH SWEETCLOVER FOR SOIL IMPROVEMENT

#### TWO-YEAR ROTATIONS

The simplest type of cropping system is found on those farms on which the usual practice is to alternate corn and small grain in a 2-year rotation. On these grain farms sweetclover is used primarily as a catch crop for soil improvement and so does not call for any readjustment of the established cropping system. The rotation is as follows:

First year.....	Corn.
Second year.....	Small grain—oats, barley, or wheat—seeded to sweetclover.

<sup>6</sup> Iowa Agriculture Experimental Station Bulletin 331, Choosing Legumes and Perennial Grasses.

Seeded with small grain in the spring, sweetclover normally makes a vigorous growth after the grain is harvested and may be pastured in the fall, or, particularly in the southern part of the Corn Belt, all or a part of the fall crop may be cut for hay. On the average-sized farm the acreage in sweetclover is sufficient to provide all the hay and fall pasture. As a rule the crop is plowed under in the spring of the second year for corn. On some farms, where the acreage to be plowed is large, a part of the crop is plowed under in the fall of the first year and the remainder the following spring.

### THREE-YEAR ROTATIONS

In other cash-grain areas 3-year rotations are in general use. The most common of these is found where corn occupies approximately two-thirds of the cropland. Such a rotation is as follows:

First year.....	Corn.
Second year.....	Corn.
Third year.....	Small grain—oats, barley, or wheat—seeded to sweetclover.

This is a very satisfactory rotation for the more fertile areas in which one leguminous crop in 3 years is enough to maintain soil productivity. A modification of this system is used in some sections, particularly in the eastern part of the Corn Belt and in other localities where the commercial production of soybeans is becoming increasingly important. This is as follows:

First year.....	Corn.
Second year.....	Soybeans, or part soybeans and part corn.
Third year.....	Small grain—oats, barley, or wheat—seeded to sweetclover.

Under each of these systems sweetclover is handled in the same way as in the 2-year rotation. One advantage these systems have over the 2-year rotation is that the acreage of sweetclover to be plowed under in the spring is proportionately less, thus permitting a better distribution of labor.

In sections in which small grain, particularly winter wheat, is a dominant crop, a common 3-year rotation is:

First year.....	Corn.
Second year.....	Small grain—oats or barley.
Third year.....	Small grain—usually wheat—seeded to sweetclover.

The modifications of this system are varied and numerous. Some farmers make a practice of growing wheat 2 years in succession, seeding sweetclover in the second crop. Some sow sweetclover in both small-grain crops, that sown in the first crop being plowed under in late July or August in preparation for winter wheat.

### FOUR-YEAR ROTATIONS

Four-year rotations on grain farms are more commonly found in sections in which corn and small grain are about equally important, and in which the soil is generally in a relatively high state of productivity. The usual rotation is as follows:

First year.....	Corn.
Second year.....	Corn.
Third year.....	Small grain—usually oats.
Fourth year.....	Small grain—usually wheat—seeded to sweetclover.



This is the rotation recommended in the so-called "Illinois system of permanent soil fertility." Several modifications of the system are in use. In one, soybeans are substituted for the first small-grain crop. In another, sweetclover is seeded in both small-grain crops and handled in the same way as outlined in the third 3-year rotation. A practice followed by some, which has considerable merit, is to seed Hubam sweetclover in the first small-grain crop. As this variety is an annual it makes a growth that has considerable fertilizing value by the time it is plowed under for the fall seeding of wheat. Another advantage is that it is killed by this plowing and does not volunteer in the wheat the following spring.

#### **SWEETCLOVER IN CROPPING SYSTEMS ON GRAIN AND LIVESTOCK FARMS**

On combination grain-and-livestock farms sweetclover occupies a more important place in the cropping system than on grain farms. It serves as the main source of pasture and soil improvement and supplements other hay crops. By utilizing both the first-year and second-year crops continuous grazing for the livestock is provided from early spring until late in the fall. As a general rule both first-year and second-year crops are used for pasture, although the first-year crop is not grazed so extensively in the eastern and northern parts of the region as in the central and southern portions. On many farms the acreage sown to sweetclover is considerably more than is needed for pasture, especially for the second year, when from one to three head of cattle can be carried to the acre. Under these conditions it is usual to set aside an acreage of the second-year crop sufficient to supply the pasture needs and then cut the remainder for hay or seed, or for both. Hay to supply the farm requirements may be made from the first-year crop except in the northern half of the Corn Belt, where the first year's growth seldom grows large enough for this purpose. In that case part of the second-year crop may be utilized for hay.

#### **THREE-YEAR ROTATIONS**

A 3-year cropping system in which corn, oats, barley, and sweetclover are the principal crops appears to meet best the requirements of farms that have some kind of livestock production as the major enterprise. The following is the usual rotation:

First year.....	Corn.
Second year.....	Small grain—usually oats and barley—seeded to sweetclover.
Third year.....	Sweetclover for pasture, hay, and seed.

This cropping system is in more general use than any other; approximately one-fourth of all farms studied, and more than two-thirds of those in southern Wisconsin, southern Minnesota, and southeastern South Dakota, were using it. It seems to be especially adapted to conditions in the northern part of the Corn Belt, and as it supplies abundant pasture it is particularly suitable for farms on which dairying is important.

## FOUR-YEAR ROTATIONS

Four-year cropping systems on combination grain-and-livestock farms are of two rather distinct types, one being confined more generally to the eastern and the other to the western part of the Corn Belt. Various crop combinations are used in each. The following is the most common in the eastern sections:

First year.....	Corn.
Second year.....	Small grain—oats or barley.
Third year.....	Small grain—usually wheat—seeded to sweet-clover.
Fourth year.....	Sweetclover pasture.

As sweetclover is not so commonly used as a hay crop in the eastern part of the Corn Belt a usual variation of this rotation, especially on dairy farms, is to substitute soybeans for hay for all or a part of the small grain the second year. On other farms a seeding of sweetclover is made as a catch crop in the first crop of small grain and is plowed under for wheat.

The 4-year cropping system most common to western sections of the region, and the one in more general use than any other system except the 3-year rotations outlined on page 21 is as follows:

First year.....	Corn.
Second year.....	Corn.
Third year.....	Small grain—usually oats and barley—seeded to sweetclover.
Fourth year.....	Sweetclover pasture.

This system is rather general in sections in which corn is the dominant crop and in which cattle feeding is an important enterprise on the farm. It is probably followed more closely than the 4-year system common to eastern sections of the region.

## FIVE-YEAR ROTATIONS

Five-year cropping systems are followed on many farms. These systems are generally more varied than are the shorter rotations and frequently have been adopted to meet peculiar conditions existing in a relatively small section or on an individual farm. The most common 5-year rotation is as follows:

First year.....	Corn.
Second year.....	Corn.
Third year.....	Small grain—usually oats or barley.
Fourth year.....	Small grain—wheat or oats—seeded to sweet-clover.
Fifth year.....	Sweetclover pasture or seed.

On some farms a practice is made of seeding sweetclover in the first small-grain crop and plowing this under in preparation for winter wheat. In sections that have exceptionally strong cornland, as in the Missouri River Valley of western Iowa and northwestern Missouri, the usual 5-year rotation used is corn 3 years, small grain 1 year, and sweetclover 1 year. Another system that is better for soils of average fertility is:

First year.....	Corn.
Second year.....	Small grain—usually oats—seeded to sweet-clover.
Third year.....	Corn.
Fourth year.....	Small grain—wheat or oats—seeded to sweet-clover.
Fifth year.....	Sweetclover pasture or seed.

The advantage of this system lies in the fact that a sweetclover crop precedes each corn crop. If sweetclover is harvested for seed or allowed to mature seed in the pasture, it frequently happens that this crop will volunteer in the first crop of small grain; but with the present low cost of seed, it is not advisable to depend on obtaining a volunteer stand.

From the standpoint of efficient use of land and labor this is one of the best rotations for Corn Belt farms. It provides (1) a crop of sweetclover before every crop of corn, (2) equal distribution between fall and spring plowing, (3) plowing of not more than one-fifth of the land at any one time, and (4) twice as many acres of first-year sweetclover pasture as of second-year.

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<i>Under Secretary</i> .....	M. L. WILSON.
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<i>Director of Research</i> .....	JAMES T. JARDINE.
<i>Solicitor</i> .....	MASTIN G. WHITE.
<i>Agricultural Adjustment Administration</i> .....	H. R. TOLLEY, <i>Administrator.</i>
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<i>Bureau of Agricultural Engineering</i> .....	S. H. MCCRORY, <i>Chief.</i>
<i>Bureau of Animal Industry</i> .....	JOHN R. MOHLER, <i>Chief.</i>
<i>Bureau of Biological Survey</i> .....	IRA N. GABRIELSON, <i>Chief.</i>
<i>Bureau of Chemistry and Soils</i> .....	HENRY G. KNIGHT, <i>Chief.</i>
<i>Commodity Exchange Administration</i> .....	J. W. T. DUVEL, <i>Chief.</i>
<i>Bureau of Dairy Industry</i> .....	O. E. REED, <i>Chief.</i>
<i>Bureau of Entomology and Plant Quarantine</i> .....	LEE A. STRONG, <i>Chief.</i>
<i>Office of Experiment Stations</i> .....	JAMES T. JARDINE, <i>Chief.</i>
<i>Farm Security Administration</i> .....	W. W. ALEXANDER, <i>Administrator.</i>
<i>Food and Drug Administration</i> .....	WALTER G. CAMPBELL, <i>Chief.</i>
<i>Forest Service</i> .....	FERDINAND A. SILCOX, <i>Chief.</i>
<i>Bureau of Home Economics</i> .....	LOUISE STANLEY, <i>Chief.</i>
<i>Library</i> .....	CLARIBEL R. BARNETT, <i>Librarian.</i>
<i>Bureau of Plant Industry</i> .....	E. C. AUCHTER, <i>Chief.</i>
<i>Bureau of Public Roads</i> .....	THOMAS H. MACDONALD, <i>Chief.</i>
<i>Soil Conservation Service</i> .....	H. H. BENNETT, <i>Chief.</i>
<i>Weather Bureau</i> .....	F. W. REICHELDERFER, <i>Chief.</i>